

Control circuit for relay-operated gas valves

This application claims priority to PCT/EP2005/002856,  
filed on March 17, 2005, which claims priority to  
5 DE102004045031.5 filed on September 15, 2004 and to  
DE102004016764.8 filed on April 1, 2004.

Technical Field

The invention relates to a control circuit for relay-  
10 operated gas valves.

Background

Gas valves are known which are opened and closed via a  
relay. It is also known for such relays for opening and  
15 closing gas valves to be activated via a control device,  
often in the form of a microprocessor. It can be  
important here that the overall arrangement is failsafe,  
i.e. that a gas valve is only opened via a relay when the  
control device is in a defined state. If an undefined  
20 state of the control device is present, it is desirable  
that the relay not open the gas valve. For this, control  
circuits for relay-operated gas valves sometimes have a  
failsafe circuit in addition to the relay, where the  
failsafe circuit is connected between the control device  
25 and the relay. The failsafe circuit may help ensure the  
failure safety of the overall arrangement.

Summary

According to one illustrative embodiment of the present  
30 invention, a control circuit may be provided that  
includes a relay for opening and/or closing a gas valve,  
and a failsafe circuit. A control device may be  
connectable to one or more input of the failsafe circuit,  
and the failsafe circuit may be adapted to only supply  
35 the relay with a voltage and/or current necessary for  
opening the gas valve when an input signal supplied at an  
input of the failsafe circuit by the control device has,

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for example, at least two different frequency signals succeeding each other in time.

In accordance with this illustrative embodiment, the  
5 relay can accordingly only open a gas valve if the signal supplied by the control device contains the two frequency signals in the time-defined order. If only one of the two frequency signals is present, the relay cannot open the gas valve. This helps ensure that the relay can only  
10 actuate the gas valve if the control device, often in the form of a microprocessor, is working properly. If the control device supplies a signal with other frequencies or a different time sequence of frequencies at the input of the failsafe circuit, the gas valve may be closed,  
15 sometimes immediately.

In some illustrative embodiments, the control circuit may have a charging circuit and a drive circuit for the relay. In some cases, the charging circuit has at least one  
20 capacitor, the charging circuit charging the at least one capacitor of the charging circuit upon the application or presence of a first frequency signal in the input signal. Upon the application or presence of a second frequency signal, on the other hand, the at least one capacitor of  
25 the charging circuit discharges itself. Upon the application or presence of the second frequency signal in the input signal, the drive circuit for the relay may supply the relay with a voltage and/or current necessary for opening the gas valve.

30 In some cases, the drive circuit may have at least two transistors, a base of a first transistor being connected via a resistor to the capacitor of the charging circuit, and the first transistor of the drive circuit only  
35 conducting when the capacitor of the charging circuit discharges itself upon the application of the second frequency signal in the input signal.

Brief Description

The invention may be more completely understood in  
5 consideration of the following detailed description of an  
illustrative embodiment of the present invention in  
connection with the accompanying drawings, without being  
restricted to this or other illustrative embodiments, in  
which:

10 Fig. 1 shows a circuit diagram of an illustrative control  
circuit that can be used in conjunction with  
relay-operated gas valves; and  
Fig. 2 shows a timing diagram for clarifying the  
15 functioning of the illustrative control circuit  
of Fig. 1.

An illustrative embodiment of the present invention will  
now be described in greater detail with reference to Fig.  
20 1 and Fig. 2.

Fig. 1 shows a control circuit 10 according to one  
illustrative embodiment for relay-operated gas valves.  
The illustrative control circuit includes a relay 11 and  
25 a failsafe circuit 12 for the relay 11. The illustrative  
failsafe circuit 12 has an input 13, at which a control  
device, not shown, in particular a control device such as  
a microprocessor, can be connected. The control device  
supplies an input signal at the input 13 of the failsafe  
30 circuit 12 or at the input 13 of the control circuit 10.  
The failsafe circuit 12 may be adapted to then only  
supply at the relay 11 a voltage and/or current necessary  
for opening the gas valve when, for example, a signal  
having at least two different frequency signals  
35 succeeding each other in time is supplied at the input 13  
by the control device.

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In one illustrative embodiment, and not to be limiting, the failsafe circuit 12 of the control circuit 10 may include a charging circuit 14 and a drive circuit 15. The illustrative charging circuit 14 includes the components  
5 surrounded by a dashed box in Fig. 1; the components of the drive circuit 15 are surrounded in Fig. 1 by a dotted and dashed box.

As can be seen from Fig. 1, the illustrative charging  
10 circuit 14 includes a capacitor 16, with two diodes 17 and 18 connected in parallel to the capacitor 16. Fig. 1 shows that the cathode of the diode 18 is in contact with the anode of the diode 17. The capacitor 16 is connected in parallel to the two diodes 17 and 18 in such a manner  
15 that the capacitor is in contact with the cathode of the diode 17 on one side and with the anode of the diode 18 on the other side. Connected between the two diodes 17 and 18 is a resistor 19, which with interposed capacitors 20, 21, 22 and 23 is connected to the input 13 of the  
20 failsafe circuit 12. Instead of the four capacitors 20 to 23 shown in Fig. 1, it is also possible to use only one capacitor, or any other number of capacitors as desired of appropriately sized capacity.

25 The illustrative drive circuit 15 includes, among other things, two transistors 24 and 25. A first transistor 24 is connected with its base to the capacitor 16 of the charging circuit 14, with an interposed resistor 26. The collector of the transistor 24, which according to the  
30 illustrative embodiment of Fig. 1, is developed as an NPN transistor, is connected with an interposed further resistor 27 to a supply voltage V of the control circuit 10. With its emitter, on the other hand, the transistor 24 is connected to a ground potential or earth potential.  
35 A second transistor 25 is switched with the first transistor 24 in such a manner that the collector of the second transistor 25, which like the first transistor 24

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is developed as an NPN transistor, is connected to the base of the first transistor 24. The emitter of the second transistor 25 is connected, like the emitter of the first transistor 24, to the ground potential or earth potential. The base of the second transistor 25 is connected with an interposed resistor 28 to the input 13 of the control circuit 10.

According to the illustrative embodiment of Fig. 1, the illustrative drive circuit 15 may include, in addition to the two transistors 24, 25 and the resistors 26, 27 and 28, two Darlington transistor circuits 29 and 30, each of which has two transistors switched in the so-called Darlington circuit. According to Fig. 1, the two transistors of the Darlington transistor circuit 29 are developed as NPN transistors, the two transistors of the Darlington transistor circuit 30 on the other hand being developed as PNP transistors. In the illustrative embodiment, the two Darlington transistor circuits 29 and 30 are connected together at their base and coupled to the collector of transistor 24. It can further be seen from Fig. 1 that the emitters of the Darlington transistor circuits 29 and 30 may also be connected to each other, a series connection of a resistor 32 and a capacitor 33 being in contact at this connection point 31 of the emitters. The collector of the Darlington transistor circuit 29 is shown connected to the potential of the supply voltage V; the collector of the Darlington transistor circuit 30, on the other hand, is shown connected to the ground potential together with the emitters of the transistors 24 and 25. A diode 34 is connected in parallel to the relay 11, the diode 34 being connected with its anode coupled to the collector of the Darlington transistor circuit 29 and with its cathode coupled to the capacitor 33.

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As already mentioned, the illustrative control circuit 10 or the failsafe circuit 12 of the same may only supply the relay 11 with a voltage necessary for opening the gas valve when, for example, an input signal including at least two different frequency signals succeeding each other in time is supplied at the input 13 of the failsafe circuit 12 by the control device. In this case a defined operating state of the control device for opening the gas valve is present.

10 In one illustrative embodiment, and although not required, the gas valve may be only opened by the relay 11 if the signal supplied by the control device at the input 13 includes two frequency signals, namely a first  
15 frequency signal with a frequency of around 1000 kHz and a second frequency signal with a frequency of around 5 kHz, which are applied or present succeeding one another in time in such a manner in the signal supplied by the control device, that in each case a time span of around  
20 40 ms with the first frequency signal of around 1000 kHz is followed by a time span of around 80 ms with the second frequency signal of around 5 kHz. Fig. 2 visualizes such an input signal, as supplied by the control device, as a solid line, where in each case a  
25 time span  $t_1$  with the frequency signal of around 1000 kHz is followed by a time span  $t_2$  with the frequency signal of around 5 kHz.

The illustrative control circuit 10 may work in such a  
30 manner that upon the application or presence of the first frequency signal of around 1000 kHz at the input 13 of the failsafe circuit 12, the charging circuit 14 charges the capacitor 16 of same. During the application of the second frequency signal of around 5 kHz at the input 13,  
35 on the other hand, the capacitor 16 of the charging circuit 14 cannot be charged, but instead during the time span in which the second frequency signal of around 5 kHz

is applied, a discharge of the capacitor 16 of the charging circuit 14 takes place through the resistor 26 and the base of the transistor 24. It should further be noted that during the time span in which the second  
5 frequency signal of around 5 kHz is applied at the input 13, there may be a generally rectangular 5 kHz signal at the connection point 31. Thereby, on the one hand, the capacitor 33 of the drive circuit 15 is charged over the diode 34, and on the other hand there is a discharge over  
10 the relay 11. In the discharge, a direct current may flow through the relay 11. In the time span in which the first frequency signal of around 1000 kHz is applied, the capacitor 33 of the drive circuit 15 can also discharge over the relay 11. In the illustrative embodiment, the  
15 transistor 24 of the drive circuit 15 is only conducting if from the discharge of the capacitor 16 a current flows at its base.

During the time span in which the first frequency signal  
20 with the relatively high frequency of around 1000 kHz is applied at the input 13, the capacitor 16 of the charging circuit 14 is indeed being charged, but the drive circuit 15 is not conducting because of, for example, the so-called feedback capacity of the transistor 25 and because  
25 of the relatively large resistor 28. In the illustrative embodiment, the drive circuit 15 is only conducting when, during the time span in which the second frequency signal with the relatively low frequency of 5 kHz is applied at the input 13, the capacitor 16 of the charging circuit 14  
30 discharges through the resistor 26 and the base of the first transistor 24. The charging and discharging of the capacitor 16 of the charging circuit 14 during the time spans  $t_1$  and  $t_2$  with the different frequency signals is represented in Fig. 2 by the broken line 35. As can be  
35 seen from Fig. 2, the capacitor 16 is charged during the time span  $t_1$  in which the first frequency signal of around 1000 kHz is applied, while a discharge of the

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capacitor 16 occurs during the time span  $t_2$  in which the second frequency signal of around 5 kHz is applied.

By supplying a signal at the input 13 of the control  
5 circuit 10, in which the signal includes the two  
frequency signals of around 1000 kHz and around 5 kHz  
succeeding each other in a defined time, a voltage and/or  
current necessary to open the gas valve can be  
permanently supplied at the relay 11. In the time span in  
10 which the first frequency signal of around 1000 kHz is  
applied at the input 13, the capacitor 33 of the drive  
circuit 15 discharges, as a result of which the voltage  
and/or current necessary to open the gas valve is  
maintained at the relay 11. During the time span for  
15 which the second frequency signal of around 5 kHz is  
applied at the input 13 and the capacitor 16 of the  
charging circuit 14 discharges, the drive circuit 15 is  
conducting and there is a rectangular 5 kHz signal at the  
connection point 31. As a result of this, on the one hand  
20 the capacitor 33 is charged over the diode 34, and on the  
other hand there is a discharge over the relay 11. In the  
discharge a direct current flows through the relay 11.  
During the presence of the first frequency signal of  
around 1000 kHz, the transistor 25 is continuously  
25 conducting, as a result of which the voltage at the  
emitters of the Darlington transistor circuits 29 and 30  
becomes high. Since during the time span in which the  
first frequency signal of around 1000 kHz is applied at  
the input 13, the voltage necessary to open the gas valve  
30 is maintained at the relay 11 by the discharge of the  
capacitor 33, this time typically should be shorter than  
the discharge time of the capacitor 33.

The actual design of the control circuit described above  
35 is up to the person skilled in the art who is addressed  
here. In the especially preferred embodiment, the  
capacitance of the capacitor 16 of the charging circuit



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is 10  $\mu\text{F}$ , the capacitance of each of the capacitors 20, 21, 22, 23 is 100 pF. The capacitance of the capacitor 33 of the drive circuit is preferably 47  $\mu\text{F}$ . The resistor 19 is preferably sized at 1 k $\Omega$ , the resistor 28 at 1 M $\Omega$ . The  
5 resistor 26 is preferably 47 k $\Omega$ , the resistor 27 100 k $\Omega$ . The resistor 32 is preferably 51 $\Omega$ . The supply voltage V is 24 V. With this sizing for the circuit components, the discharge time of the capacitor 16 through the resistor 26 is about 116 ms, its charge time is about 40 ms.

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Reference number list

10	Control circuit
11	Relay
12	Failsafe circuit
13	Input
14	Charging circuit
15	Drive circuit
16	Capacitor
17	Diode
18	Diode
19	Resistor
20	Capacitor
21	Capacitor
22	Capacitor
23	Capacitor
24	Transistor
25	Transistor
26	Resistor
27	Resistor
28	Resistor
29	Darlington transistor circuit
30	Darlington transistor circuit
31	Connection point
32	Resistor
33	Capacitor
34	Diode